Systemic Building Blocks for Creating and Capturing Value from Circular Economy

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Abstract

The idea of a circular economy has generated widespread academic, policy and business interest for its potential to address economic, ecological and societal concerns posed by current production and consumption systems. The growth in the number of academic publications reflects a period of critique, clarification and validation leading to research challenges, questions and a call for real world evidence of how the ideas translate into practice, evidence of outcomes and operational effectiveness. Whilst there has been extensive research into the classifications of circular business models, these are rarely linked to a discussion of actual circular value realisation within real world settings. In this paper we draw on three illustrative examples used within a global executive education programme to reflect on the locus of circular value creation and capture. Specifically, we explore the role and interplay of four configurable 'building blocks': circular design, business models, reverse network management and system enablers, as a potentially useful heuristic to describe how businesses are realising value from their circular economy practices. These cases illustrate that the success of large scale value creation and capture derives from the iteration of multiple, boundary spanning activities emerging over time in varying configurations. There is now a need to move from classification and description to quantification and testing of how value is created and captured from circular economy in different contexts. Circular economy validation requires rapid growth in building a credible research evidence base of successful case examples.

Key words: circular economy, circular business models, building blocks, value creation, value capture

1. Introduction

The term circular economy (CE hereafter) has gained prominence as a potential means to address numerous economic, environmental and social challenges and unlock innovation opportunities for a new type of growth to a linear 'take-make-dispose' paradigm. The shift from linear to circular thinking has been referred by some as a paradigm shift. Nußholz (2017), for example, defines CE as "a paradigm that suggests a redesign of the current linear economic system, largely based on linear resource flows, towards closed-loop resource flows that can preserve the embedded environmental and economic value in products over time. The circular economy has the potential to lead to increased resource efficiency and generate environmental gains through reduced raw material extraction and waste generation" (p.1). The prospect of a CE is alluringly attractive and has catalysed global networks of leading companies, governments, higher education institutions and small-medium enterprises to collaborate and share best practices on CE implementation (Geissdoerfer et al., 2017). Several countries and regions, e.g., China, the USA, the European Union and its member states, and most notably the Netherlands, the UK and the Nordic countries, are pushing for the implementation of the CE with legal and financial interventions (Ekins et al., 2018; Murray et al., 2017; Prieto Sandoval et al., 2018). Academically, the CE has started generating a significant level of curiosity (Bruel et al., 2018; Esposito et al., 2018; Mayer et al., 2018). Yet, more efforts to contribute to the field consolidation are welcomed (Kjaer et al., 2018; Merli et al., 2018; Reike et al., 2018).

In this article we contribute to the development of the CE literature by taking forward the challenge posed by Babbitt et al. (2018) to test "the real-world implementation of theoretical circular economy tools, while at the same time using findings and challenges illuminated by applications to generate new research questions" (Babbitt et al., 2018: 1). We revisit the practitioner's literature presented in the Ellen MacArthur Foundation (EMF hereafter) 2012's report *'Towards the Circular Economy. Economic and business rationale for an accelerated transition'*. This report proposed a series of simple principles and building blocks as practical heuristics to frame circular value creation, specifically the importance of a systemic focus on four key building blocks (i.e., product/service design, business model, reverse network management and system enablers). Using practical real world examples and modelling prospective scenarios, the report demonstrated a potential multibillion economic and business opportunity. Since then, numerous academic papers have been published to develop classification systems for circular business models (CBMs hereafter) (Fraccascia et al., 2019). These advances provide conceptual clarification and demonstrate the wide number of value creation models that have the potential to deliver value creation and capture. The extent to which they actually create and capture value is, however, less well researched or published, often due to commercial sensitivity. Moreover, the differentiation and interplay between a CBM and design, reverse networks and wider system requirements, is often blurred. Circular value creation is, however, an inherently boundary spanning activity – requiring cross functional teams and new or enhanced forms of external collaboration and system configurations. Therefore, we argue that the original practitioner's heuristic developed by the EMF is useful to retain the systemic requirements for large scale value realisation.

This article contributes to the literature on structure/component-based approach in business models (BMs hereafter) and CBMs research (e.g., Bocken et al., 2014; Lüdeke-Freund et al., 2019; Nußholz, 2018; Osterwalder and Pigneur, 2010; Ranta et al., 2018; Richardson, 2008) placing the building block focus into a complementary, activity system perspective. Our approach aligns with the wider research literature wherein the BM is seen as "a system of interdependent activities that transcends the focal firm and spans its boundaries" (Zott and Amit, 2010: 216), or as subsequently put by Zott et al. (2011), "a firm centric, yet boundary-spanning activity system" (p. 1037). This places emphasis on the complex relations in a value network necessary for creating and capturing value, with the BM viewed within its web of suppliers, customers and partners and conceptualised as a set of relations and transactions between a focal firm and its networks (Zott and Amit, 2010). Bidmon and Knab (2018) counsel that when viewed under boundary-spanning lens, BMs can yield interesting insights into how a transition to a new system might develop because "they allow zooming in on organizations without losing the systemic perspective" (p. 913). Equally, the four building blocks devised by the EMF, although not directly overlapping with the activity system perspective above described, operate as an 'activity system', as they provide a way of conceptualising how real world companies are realising circular value. As a result, this article contributes to the CBMs literature, which various authors have concluded as insufficiently developed (Kirchherr et al., 2017; Lüdeke-Freund et al., 2019; Ranta et al., 2018), wherein a limited understanding of the relationship between circular strategies and the factors influencing their effective and successful implementation coexists (Sousa-Zomer et al., 2018) alongside little evidence about how they create 'value' (Hopkinson et al., 2018; Merli et al., 2018; Ranta et al., 2018). Furthermore, our study is consistent with the approach taken by authors in this journal (e.g., Sousa-Zomer et al., 2018) who analyse CBMs implementation alongside the engagement of multiple organisational functions and stakeholders and alignment to external conditions.

The remaining parts of this article are structured as it follows. In the next paragraph, we summarise CE thinking and principles to give some conceptual grounding to the arguments that we develop in the subsequent sections of the paper. We also briefly sketch the 'state-of-the-art' of research at the intersection between CE and BMs. Next, we revisit the original grounding principles and building blocks from the 2012's EMF study as the basis for structuring the discussion about real world, circular business examples derived from a range of primary and secondary data. We conclude with paragraph four, which highlights this research contribution and suggests ideas for further research endeavours.

2. Circular Economy and Circular Business Models

The idea of a CE has renewed attention onto the potential to design a new economy that decouples growth from resource throughput. Whilst there are many definitions, and different perspectives in different geo-regions, the growth of academic interest has been largely driven by the work of the EMF who defined the CE as "an economy regenerative and restorative by intention and design" (EMF and McKinsey, 2012: 7), and that provides opportunities for "multiple value creation mechanisms decoupled from the consumption of finite resources" (EMF et al., 2015: 14).

Since 2012 academic interest in CE has grown substantially. In a recent review of the CE, involving a large sample of scientific outputs (n= 601), Merli et al. (2018) find that over three quarters of the literature examined was published between 2013 and 2017. Academic research is approaching the CE from many different angles. Studies are exploring: the conceptualisation (e.g., Geisendorf and Pietrulla, 2017; Kirchherr et al., 2017; Korhonen et al., 2018; Murray et al., 2017); supply chain management implications (e.g., De Angelis et al., 2018; Govindan and Hasanagic, 2018; Masi et al., 2017; Mishra et al., 2018); relations with antecedents, originators and sustainable development (e.g., D'Amato et al., 2017; Geissdoerfer et al., 2017; Moreau et al., 2017; Sauvé et al., 2016); implementation across different geographical areas (Domenech and Walkowiak, 2018; Ghisellini et al., 2016; Kirchherr et al., 2018; Winning et al., 2017); indicators and standards (e.g., Di Maio et al., 2017; Elia et al., 2017; Franklin-Johnson et al., 2016; Pauliuk, 2018); circular design (e.g., De los Rios and Charnley, 2017; Moreno et al., 2016); CBMs (e.g. Bocken et al., 2016; De Angelis, 2018; Hopkinson et al., 2018; Linder and Williander, 2017; Nußholz, 2017; Oghazi and Mostaghel, 2018; Ranta et al., 2018), and potential benefits and limitations (Cullen, 2017; Ghisellini et al., 2018; Santos et al., 2017; Schroeder et al., 2018; Zink and Geyer, 2017) among other themes.

A core interest amid academic researchers has been CBMs recognised as focal point for value realisation (Hopkinson et al., 2016; Webster, 2013; Zucchella and Previtali, 2019). Scholars have identified: definitions (e.g., Linder and Williander, 2017; Nußholz, 2017); categories (e.g., Lacy and Rutqvist, 2015; Weetman, 2017); strategies (e.g., Bocken et al., 2016; Geissdoerfer et al., 2018); archetypes (e.g., Kortmann and Piller, 2016; Moreno et al., 2016); frameworks (e.g. Antikainen and Valkokari, 2016; Ranta et al., 2018); canvasses (e.g., Lewandowski, 2016); taxonomies (e.g., Urbinati et al., 2017); typologies (Lüdeke-Freund et al., 2019), and mapping tools (e.g., Nußholz, 2018).

Whilst proliferation of divergent constructs classifying/categorising CBMs is to be expected, this emphasises the need for conceptual clarification to avoid confusion (De Angelis, 2018) and barriers to implementation (Kalmykova et al., 2018; Kirchherr et al., 2017; Reike et al., 2018) with Kirchherr et al. (2017) warning that "a concept with various understandings may ultimately collapse or remain in a deadlock due to permanent conceptual contention" (p. 221). The CBMs literature is largely dominated by analytical efforts to 'structure', producing typologies and taxonomies of different BMs (Fraccascia et al., 2019) leading to a perspective that BMs are not simply static entities but are complex and dynamic, which demands that a systemic view - embracing the entire value network alongside consideration of different elements and their relations in the system- is used (Fraccascia et al., 2019; Frishammar and Parida, 2019). Furthermore, the research evidence of how CE leads to value realisation within companies and whether it is effective and viable, remains elusive.

The value realisation potential of CE was originally conceptualised by EMF as a series of boundary spanning principles which themselves draw from and synthesise ideas from a number of antecedent and concurrent schools of thought such as industrial ecology (e.g., Frosch and Gallopoulus, 1989), economics (e.g., Boulding, 1966; Pearce and Turner, 1990), biomimicry (Benyus, 2002), natural capitalism (Lovins et al., 1999), blue economy (Pauli, 2010), performance economy (Stahel, 2006), regenerative design (Lyle, 1994) and cradle-to-cradle® (Braungart et al., 2007). The current version of the three core principles is:

- *Preserve and enhance natural capital*: industrial metabolism should not create further damages to the ecosystem but rather restore it. Concrete actions to implement this principle would incorporate the use of renewable energies and materials whenever possible as well as building natural capital by returning to nature biological nutrients when cascading across different usage is no longer possible (EMF et al., 2015);

- *Optimise resource yields*: the inefficient and ineffective use of resources in a linear economy gives way to maximising resources productivity in circular production systems. This means: a) adopting recovery strategies that preserve materials value across technical and biological cycles (sharing, re-using, remanufacturing, refurbishing, recycling, returning to nature); b) extending product durability (*ibid.*);
- *Foster system effectiveness*: increased resource efficiency is only but one of the ambitions of the CE, which ultimately aims for the elimination of negative environmental externalities, and so pollution in its various forms (*ibid.*).

In this characterisation, value creation potential derives from the circulation and flows of technical and biological materials, products and components through the economy. These flows were characterised as four simple value loops referred to as the '*power of loops*' which formed a key underpinning for the famous 'butterfly' diagram. The realisation of these 'value loops' are dependent on the focus and configuration of four simple building blocks: providing a set of practices that in combination would enable 'circulation …at the highest value...' . In the original conceptualisation it was stressed that the greatest value creation would be achieved by configuring these building blocks systemically. Configuring one block in isolation could realise value opportunities but could also lead to value leakage and lost opportunity. For example: designing cradle to cradle® products, might deliver benefits at the point of consumption but these products may still likely end up in landfill if there is no accompanying BM to incentivise return or a reverse flow management system; the potential of capturing value from a specific BM (e.g. remanufacture) will be reduced or lost if the returning product and service is not designed for ease of disassembly, repair or upgrade or the reverse logistics solution is too expensive or lacks integration at the outset.

Some of the essential features of the four building blocks are as follows:

a) *circular product design and production*: product and service design forms a key aspect of circular value creation. A key principle of CE is that materials flow in technical (synthetic materials) and biological (renewable materials) cycles and that design decision should define which cycle a product and its constituent materials are designed for. In technical cycles products and materials are used and value can be realised via a range of product service value propositions and different end-of-first-life strategies, i.e., maintenance, repairing, remanufacturing, refurbishing, recycling. The ability to recover and recapture value from product and process design therefore, is necessary to enable effective and efficient technical materials flows. In biological cycles, materials are consumed and ultimately metabolise and decompose. In the biological cycle, value realisation derives from cascading materials across different usages and only when no further financial value can be further recovered, they are returned to nature to build and restore natural capital, which is essential for future flows of feedstocks, ecosystem services and the health of living systems. This requires that: a) the provenance of biological materials is defined at the outset; b) they are designed within products to avoid contamination from hazardous or toxic additives, which could limit their subsequent cascaded usage, and c) they can be readily separated from technical materials.

b) New business models: the ability to capture value lies at the heart of BM design. Although both value creation and value capture are required for achieving circular competitive advantage, value capture is never guaranteed—the source that creates a value increment from a given task, product, service, or activity may not necessarily succeed in capturing a majority of it in the long run or indeed much of the value creation potential may be destroyed or lost by lack of integration with the other building blocks (Lepak et al., 2007).Whilst much has been written about CBMs and many taxonomy and variants described, there are many options for capturing value but the three we consider most common and successful in a CE are: resale; performance-based delivery and internalisation. Resale or re-commerce is an established form of reintroducing products back into a market. In performance-based delivery models, the core idea is to find a form of pay-per-use remuneration for the provider (e.g. power by the hour, rate per mileage). In many cases, companies will deploy circular practices in their upstream operations or productions processes (value leakage) to improve their cost competitiveness and to improve resilience against commodity price fluctuations. In these instances, a (new) product is delivered to customers, without needing to communicate the circular elements of the offer.

c) *Reverse cycle*: whilst value creation and capture can be made internally or at the boundary of the firm, many will require wider changes in relevant parts of the value chain as firms extend their activities to the entire product life cycle. This might involve BMs progressively moving closer to a closed-loop value chain or the integration of external partners into the new product or service development process as a critical component of open BMs and open innovation (Kortmann and Piller, 2016). Large scale CBMs development builds on new forms of collaboration and the potential integration of consumers and other external partners and functional areas such as product development, manufacturing, and distribution. It opens up opportunities for start-ups and innovators to become part of the value creation and capture activities.

d) *Enablers and favourable system conditions*: the realisation of value creation, capture and distribution is dependent upon developing new collaborations, partnerships and scope of traditional value chains. A CE ecosystems, however, is not a static system and through time the volatility of commercial pressures, regulatory change and faster innovation cycles require capabilities to manage transitions back and forth and the need to be able to realign circular strategy and value shift. This requires committed resolution from management teams. Businesses can develop capabilities and enablers to working in new ways with upstream and downstream partners, looking to set standards to drive down costs or promote standards to influence consumer awareness and purchase decisions, supporting regulation for remanufacture and reuse or shifts in taxation and subsidy. For example, as Kirchherr et al. (2018) noted, many virgin material prices in the EU are 'artificially' low because of the subsidised rates at which the energy for producing these is provided. Hence, to avoid that these subsidies could undermine the use of secondary raw materials, the EU's policy should establish that all externalities are to be included into the price of resources and products (*ibid.*).

The role of these different building blocks in realising circular value opportunity is becoming more widely recognised. Pieroni et al. (2019) note that the process of BM innovation for a CE is inherently complex and requires a systemic approach, which acknowledges product design and value chain among other things. Yang et al. (2018) warn that "making supply chains circular cannot be achieved by a specific firm, as it requires collaboration between the organisations across the supply chains and other stakeholders from similar and/or diverse sectors" (p. 498). De los Rios and Charnley (2017) stress the role of design in building circular value chains given that product design has a direct influence on the way in which a value chain will be managed. Frishmann and Parida (2019) highlight the need for internal building blocks and capabilities to be aligned with wider system enablers and boundary spanning activities for successful implementation of circular business strategies. Levänen et al. (2018) also underline the importance of system level orientations: "the transition to circular economy unfolds through a succession of modifications to the national institutional frameworks and to companies' business models (…). Business models must always be weighed against the local institutional structure, which constitutes context-specific institutional enablers and voids for business activities" (p. 374). Similarly, Reike et al. (2018) emphasise the importance of the role of government and policymakers in directing agency towards more circularity: "with help of incentives like funds, subsidies, but also through activities with more indirect effects like knowledge provision, tool development, engagement, events, government can ensure a way forward" (Reike et al., 2018: 259), echoing the Green Alliance, a British think tank, which stated in 2013: "no single intervention on its own will create the tipping point for a circular economy. It is a systems problem that needs a systems solution" (Green Alliance, 2013: 28).

Nonetheless, as more recently pointed by Lüdeke-Freund et al. (2019), the discussion about the roles and importance of different partners and enablers are often overlooked in current CBMs literature. To this we add that, detailed, in-depth analyses (conceptual or empirical) - focussing on the role of the four building blocks and how they are configured or can be configured to realise to value creation and capture – have been surprisingly neglected with a tendency to concentrate on each block in isolation. Our conclusions find support in Zucchella and Previtali (2019) who argue that CBMs literature is "mainly characterized by a taxonomic and descriptive intent. (…) Beyond taxonomies, there is a growing need to identify the issues that need to be tackled for a deeper understanding of the factors involved in the adoption of circular and sustainable practices. (…) Furthermore, though it seems implicit that most of these circular business models cannot be designed and operated as "stand alone" models, the literature on circular business models mainly focuses on the single firm" (p. 275). In the next paragraph, we describe how these four building blocks provide a helpful heuristic to conceptualise the real world value creation and value capture activities in three well known circular businesses.

3. Building Blocks of a Circular Economy in Real World Circular Businesses

Empirical research into value creation and capture is challenging due to commercial sensitivity and access to data. This is as true for analysis of linear models as for circular models. The concept of systemic 'building blocks' was originally proposed in the practitioner's literature to conceptualise the idea value creation in a CE. In this paper we treat these building blocks as neither inductive not deductive but we rather followed an abductive research approach, which uses intuition and creativity, based on an incomplete set of facts to develop 'new' knowledge

(Dubois and Gadde, 2002; Kovacs and Spen, 2005). Abductive reasoning is often used to provide insights into the particularities of specific situations, experiences and settings, assess and support the development of potential conclusions and more generalisable findings within different contexts (Dubois and Gadde, 2002; Kovacs and Spen, 2005, Howard et al., 2018). Abductive reasoning is most commonly used in conjunction with case study development. We therefore adopt the abductive research approach, using a range of sources of empirical data to infer how 'circular' value has been realised from the concept of 'building blocks'.

This paper explores the role of the four building blocks through three case examples of leading large multinational organisations, all of whom are realising circular value creation and capture through varying configurations of the aforementioned building blocks. Our aim, therefore, is to describe some of the key features of the building blocks, how they interact and realise circular value in practice. Our approach builds on a range of sources of empirical data. The three case examples all feature in a Global Masterclass on Circular Economy, for the Ellen Macarthur Foundation titled Closing the Implementation gap run by one of the authors. This Masterclass features 80-100 global executives in a six week on line course, three times a year, to discuss, debate and provide insights and challenges relating to the implementation of CE in various business contexts. Each example in this paper is drawn from three case studies materials developed for the Masterclass and co-authored with representatives from the three companies. The materials include data from publicly available reports and talks, and from executives and managers within each of the companies themselves. Each case study is supported by a live webinar led by the company CE lead followed by a questions and answers session and on line forum to debate further the mechanisms of circular value.

Description of value creation and capture is challenging due to commercial sensitivity and access to data. Whilst we cannot refer to specific contributions from the Global Masterclass delegates, the course provides a close up, 'inside-out' perspective around the mechanism for value creation and capture, and a method of drawing inferences from a range of real world global companies. All inferences and interpretations are entirely ours and solely for the basis of discussion. Table 1 summarises some of the linkages between the building blocks.

	Design	Business Models	Reverse Networks	Systems
Company A	Increased recycled material content – including visible components (e.g., increased recycled plastic content to 50%), requiring new partnerships; Design requirements for new BMs and autonomous vehicles, e.g., long life battery design and recovery pathways (modular, maintenance, repair, multiple users); Design use feedback from maintenance activities to develop design criteria, such as material choices and assembly protocols.	New forms of value capture including: New mobility as a service models requiring new design criteria; Battery leasing for electric vehicles, battery repair services and new grid/energy storage services and possible implementation of a bonus or deposit scheme for care and maintenance; Scaling up of parts recovery & resale requiring new partnerships; The company incentivises customers to increase collection rates, e.g., B2B discount scheme for remanufactured components if return is guaranteed.	New value chain partnerships, collaboration and subsidiaries to enable required volumes of high quality recycled plastic feedstocks to keep up with demand ; New formal partnerships and relationships for end of life vehicle treatment; New types of collaborations and relationships for performance models, grid services.	Regulatory and financial incentives and disincentives to impact polluting vehicles, promote cleaner energy and renewables, end of life vehicle requirements; Changing markets and demand for mobility vs car ownership; Advances in material sorting technology enabling new sources of feedstock; Digital technology creating opportunity for new systems of activity (e.g., remote diagnostics, mobility as a service, parts and components tracking); Education and upskill development of workforce capabilities .
Company B	Designers and cross functional teams have a systematic and structured approach to review and evaluate new circular value propositions within the product portfolio in the overarching business system;	The company has a long standing history in reselling high value re-manufactured products with warranties as new; The company has developed a single overarching KPI and targets based on sales of circular products to drive	Shift to closed loop supply chains expanding out from collection system already exists from advanced remanufacturing operations;	Extensive internal leadership develop competences and learning to i) close professional knowledge loops, ii) develop reinforcing mechanisms & iii) , shift culture and behaviour to support new circular realisation strategies.

	A DfX method is team driven and based on a wide range of criteria explored in a step by step to increase customer satisfaction and closing future value loop; Targets include design forms to increase recycled content and zero waste to landfill; New hardware designs required for new service oriented BMs (modular, maintenance, repair, multiple users).	internal incentives, leadership and behaviours; The company is seeking to expand leasing, rental and performance based schemes for medical and consumer lifestyle products.	New global value chain partnership and collaboration are being developed to expand capabilities.	Investment in advanced remanufacturing systems; Feedback from remanufacture and repair into new designs; Learning new external partnerships and collaborations; Increased understanding of future regulatory requirements.
Company C	Core products highly suited to remanufacture and re-use; Progressive design iterations improved design for remanufacture.	BMs based on leasing (high cost of new machines makes leasing model attractive) and performance model (print as a service). Leasing means machines remain in control of the company and facilitates recovering equipment at the end of their contract; Re-useable toner and wider services provide higher revenues and margins than machines; Remanufactured machines lower cost for user and are more profitable for the company.	The combination of design principles and leasing means a reverse network designed into the value proposition at the outset; As the BM scaled, greater need to collaborate with third parties in recovery and recycling value loops (where it is not cost effective for the company to bring assets back for remanufacture).	New British Standard 'BS 8887-220:2010 Design for manufacture, assembly, disassembly and end-of-life processing (MADE)' addressed concerns of sales teams and customers about quality and warranties; Investment to enable remanufacturing infrastructure 'as new' and in practice 'better than new'; As 'new' warranties plus lower price and enhanced LCA credentials and reduced costs increased demand especially amongst public procurement (with requirements to improve 'green credentials' and best value).

3.1 *Company A*

Company A is a widely reported case study on vehicle remanufacturing. It has become the leader of electric vehicles sales in Europe. Company A's CE strategy, however, has evolved rapidly over the past 5 years to be more than simply a remanufacturing case example. It is now a pioneering multi-pronged ecosystem, integrating design, multiple value creation and capture models, new collaborations for reverse network management and the management of a range of internal and external system enablers. The company has now formulated a KPI to aggregate and summarise the net financial value creation from these activities – with a target of 100M euro by 2022 relative to 2016.

3.1.1 Value creation and capture

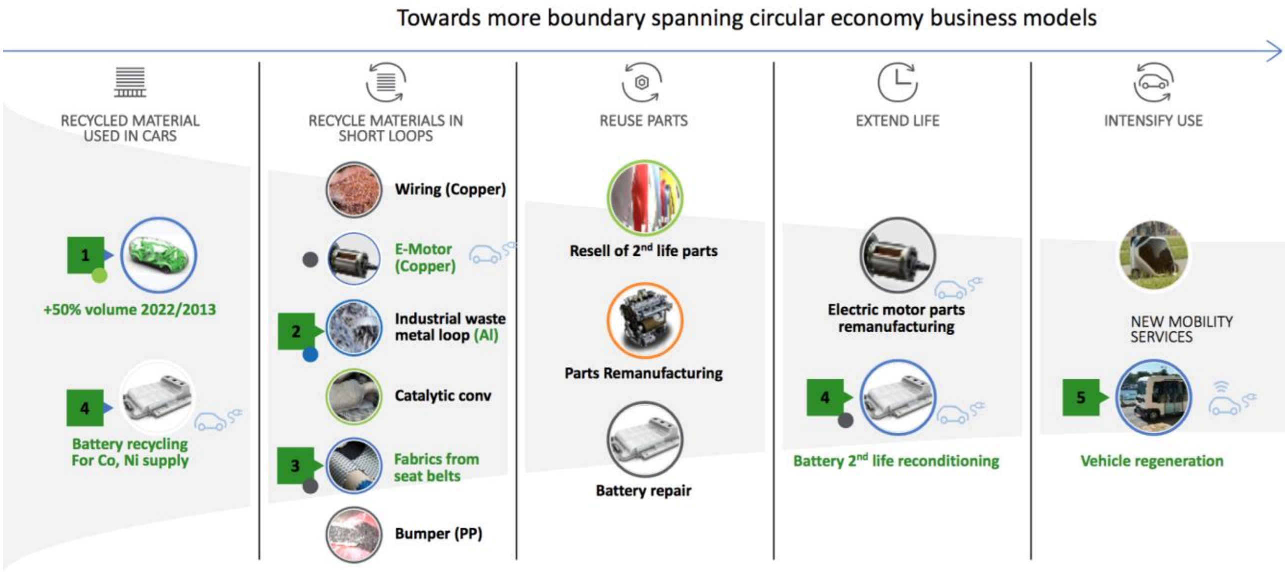
Figure 1 highlights five primary value creation and capture mechanism: recycled materials in new cars, recycling other materials in short loops, re-use of parts, remanufacture to extend life of parts and intensification of use, primarily via new mobility services and regeneration of vehicles. In combination and varying configurations, the value creation and capture process requires the company has oversight of all its vehicles, engines, batteries and materials throughout their lives, from design and production to use and reverse network management. In the case of design, the ability to have oversight of end-of-life pathways creates new requirements and opportunities for the capture and distribution of value. This includes the requirements for a detailed, auditable bill of materials for each model of vehicle, with data on recycled material content to evaluate overall recycled material and product ratio's. Increasing the percentage of recycled content of new vehicles creates new design requirements impacting on components that are visible to the customer (currently most recycled materials are not visible to the end user). In the new ecosystem, design criteria are informed by feedback from maintenance data and close loop end-of-life pathways, themselves influenced by the development of new BMs and new, collaborative reverse network partnerships. This demands new capabilities in design for remanufacture, reclaim, re-use and recycling.

The growth in circular value capture is driven by three primary mechanisms: internalisation (recovery and re-use of materials), reclaim, re-manufacture and resale of parts and new high value performance related services, including mobility as a service and new grid services- where electric batteries reaching the end of their useful life for propulsion, can be cascaded into commercial renewable energy storage and ultimately back to recycling, recovery and remanufacture in a closed loop.

These boundary spanning activities have been achieved through extended value chain coverage and new forms of collaboration and partnership to expand collection, vehicle dismantling information and asset recovery. These collaborations form core elements of the overall ecosystems including closed loop for plastics maintained wholly within the local automotive industry and pilot projects to design comprehensive, modular transport systems that will enable customers to book rides, and operators to manage and operate self-driving car fleets. As examples, a new network of 320 end of ELVs dismantlers has been established. In this scheme 350,000 vehicles sent for disassembly are checked for parts marking, weight, assembly techniques and other factors, which influence future eco-design before parts are either sold on or recycled. Other partnerships have evolved for ELV battery diagnosis and repairs, increasing revenues and profitability and creating valuable data and feedback to designers. To reach scale and manage the volatility and uncertainty in return rates, new BMs have been developed to incentivise 'vehicle' return.

The rapid scaling of circular value is an intentional and deliberate strategic response to a range of system and market place enablers including: regulatory (End of Life Vehicle, emission standards), financial (pollution and fuel taxes), changing demand (especially amongst younger adults), new technologies (especially digital enabling new BMs, pay as you go, remote diagnostics and increased data flows at each stage of the value chain to inform future value creation and capture potential) and advances in material sorting technologies (material separation, quality control). In turn, the company has developed new capabilities, knowledge and systems to take advantage of these changes and generate new forms of long term strategic value creation. In short, the company has shifted, over a 10 year period, from a traditional car manufacturer to early innovation and adoption of parts remanufacturing to an innovative new automotive, mobility, renewable energy eco-system based on the interplay between four systemic building blocks leading to quantified value creation and capture.

Figure 1. Company A: Circular Economy Value Creation and Capture Strategy


Towards more boundary spanning circular economy business models
RECYCLED MATERIAL USED IN CARS
RECYCLE MATERIALS IN SHORT LOOPS
REUSE PARTS
EXTEND LIFE
INTENSIFY USE
1
+50% volume 2022/2013
4
Battery recycling For Co, Ni supply
Wiring (Copper)
E-Motor (Copper)
2
Industrial waste metal loop (Al)
Catalytic conv
3
Fabrics from seat belts
Bumper (PP)
Resell of 2nd life parts
Parts Remanufacturing
Battery repair
Electric motor parts remanufacturing
4
Battery 2nd life reconditioning
NEW MOBILITY SERVICES
5
Vehicle regeneration

3.2 Company B

Company B is recognised as one of the world's leading technology companies, specialising in healthcare and consumer lifestyle products. Company B embarked on their current circular journey in 2012 as part of a new vision and mission as set out by the CEO.

"At Company B*, we have started the process of fundamentally redesigning our business and our end-to-end value chains. Instead of selling products, we aim to retain ownership, selling use as a service so we can optimize the use of resources. Once we can sell the benefits instead of the products themselves, we can design for multiple re-use and eventual recycling*" (Company B's CEO).

As with Company A, company B has a long standing profitable remanufacturing business unit offering a choice of pre-owned high value medical products that have been thoroughly refurbished, upgraded and quality tested. In 2016, that sought, in part, to generate 15% of revenues from circular solutions by 2020 from a baseline set at 7% in 2015. The term circular revenue is defined by the company as sales to customers in the remanufactured products, systems and components; upgrades of hardware/software and products with over 25% recycled plastic content by total weight of plastic. Each of these 'products' value loops has its own internal set of operational indicators (based on LCA, energy performance requirements etc.), but the company recognised that to focus teams, strategy and communications and scaling up the CE business required setting targets, incentives and KPI linked to sales and revenues. The 15% figure is externally validated and now forms the next stage of development within the company. This deceptively simple new indicator has galvanised functions across the business – sales, marketing, product design, to appreciate the importance of their role in CE and the strategic relevance of CE to their future business.

3.2.1 Value creation and capture

Despite impressive achievements, Company B recognises they are still in the early stages of shifting to a fully circular business, which will require transformational shifts in product and service design, BMs, reverse network management and the development of new boundary spanning collaborations and capabilities. In the consumer lifestyle business, for example, many of the products remain largely linear. Once sold, Company B is typically unable to recover any further value from them. The end fate of the product is, therefore, largely unknown. Company B has many products that operate on a single sales model, but teams are progressively working to 'clear the plate' and look at how they can redesign to deliver recurrent revenues and recoup the embedded value within their products. To begin to tackle this, the company has a process of actively mapping value leakage across a wide range of current linear products including opportunities to increase the proportion of recycled materials into new product.

At the core of this process is the Company B's Business System through which the company deploys six different forms of capital to drive value in the short, medium and long term. The alignment of the value creation process and CE is shaped around a 'Design for Excellence' (DfX) programme, to promote designing for recyclability, upgradability, and serviceability. This is stimulated by setting criteria for every product in order to challenge the business-unit managers. The DfX approach is team-driven and based on a wide range of criteria explored in a step by step to increase customer satisfaction and future value loops; to reach the targets, the businesses need to meet criteria associated with the CE, continuously raising the targets.

Meeting CE goals and targets involves multi-week workshops where the company challenges the entire value proposition of a product to see what might be changed and how. This process is co-created with suppliers as part of the learning of how to design value chains better and involves five key stages:

1. Create a cross functional project team to explore take back value and refurbishment costs for existing product;
2. Input best available data and lessons from the repair process within the existing service network, bill of materials breakdown, product lifetime to generate refurbishment scenarios;
3. Extend analysis to consider new value capture options such as leasing of product and what changes in product design might be needed to improve profitability;
4. Model different value capture options and compare profit of the new case to the direct sale/purchase base case;
5. Assess factors affecting the business sequentially and collectively.

As can be seen, this process integrates the four building blocks at the outset, on a product by product and iterative basis. This systematic approach lies at the heart of an overarching activity system based on the fundamentals of creating and capturing value from the recirculation of products, components and materials and the growth in new services. Given their size and position, the company has an important role to play as a system and market enabler, putting weight on their entire value chain, as well as by educating customers and suppliers. The company, however, recognises that there are different barriers to address and many risky assumptions to validate. As an example, in the case of just one home health care product designed on a leasing model, this may include an incentive to maintain and return the device at the end of a contract period meaning there is more than one financial transaction and money flow, compared to the 'hit and run' single sales offer. There may also be new extended relationships with 3rd parties or new service providers such as recycling companies (e.g., for the recovery of plastics and components), distributors, health care providers or those interested in the effects being monitored. A shift to increasing the proportion of renewable energy in the value chain could then bring further collaboration such as renewable energy providers, to support infrastructure for electric powered distribution systems or schemes to generate solar electricity from available land and space amongst value chain partners.

These shifts are not simply technical but require capabilities around numerous system enablers such as overcoming legal barriers with cross-border transportation and collaborative platforms. The company recognises that it can do a lot on its own, but a CE on a global scale will require a lot of players to change simultaneously. The company acknowledges that a shift from linear to circular value chains and then to multiple value cycles is by no means straightforward and introduces new levels of complexity and requirements to the management of returning assets and value streams. New BMs not only alter the flows of product, components and materials but also potentially information, energy and money.

3.3 *Company C*

Company C is a Japanese global printer, imaging and document management original equipment manufacturer (OEM) with a 40 year program in product manufacture, remanufacture and asset reuse. The company has 110,000 employees and sales of 19Bn USD in 2016, making Company C the top-ranked company in its sector by turnover. The company has featured a number of times in portfolio of CE remanufacturing case studies which shows the significant material and energy benefits of remanufacture vs manufacture of new machines and equipment. In this paper we add to those previous studies by highlighting the central importance of an asset value cascade framework, that lies at the heart of the value realisation decision making. The foundation of the company's circular value creation and capture processes is based on the building blocks of axiomatic design principles, a leasing BM, embedded reverse network capabilities and specific system enablers that guaranteed the company to overcome consumer wariness about second life equipment.

3.3.1 Value creation and capture

Company C remanufactures around 15,000 printers per annum, approximately 8% of annual sales. In addition, it recovers and remanufacturers around 250,000 toner cartridges per annum globally. The business rationale for this circular model are described in Table 1. Machines and peripherals e.g., cartridges, with highly value durable materials and components that outlast 3-5 year service contracts make it attractive to recover and resell the product. Secondly, the main revenues are derived from a performance business model based on print per page. For this to work effectively, requires a network of field staff providing both maintenance and repair services to ensure any machine down time is minimised. These field engineers also provided a ready-made reverse logistics solution at the end of contract. The growth in remanufacturing as a high value business shifted in 2007 when the company was able to utilise the new British Standard 8887, which for the first time, defined and distinguished clearly the terms remanufacture vs refurbishment and repair. This meant that OEMs, such as Company C, were able to remanufacture equipment back to their original specification and provide warranties for 'as new' to address customer concerns about buying 'second hand' equipment. The company took the decision to brand the remanufactured equipment to highlight its circular credentials, leading to a major upturn in sales to price and environmentally conscious end users.

Initially a UK and then Eurocentric business, since 2010 as the volume of returning assets increased across multiple regions globally, the company created a dedicated 3R BM. At the core of this corporate wide activity system 3R BM is based upon a 'value realization cascade' - a decision tree which was developed iteratively by managers in the 3R team (see Figure 2). This system balances the value creation and capture potential from all returning assets across all potential value loops- from maintenance, to remanufacture to eventually recycling. The primary goal is to keep machines and consumables in services as long as possible – the inner loop- as this generates the highest value and this tree was designed to rapidly define the optimum value that the company can capture from returning assets, both hardware (machines), as well as consumables and spare parts. The cascade process is embedded in the Company C's EU-wide Enterprise Resource Planning (ERP) system.

This system has been supported by developing new capabilities in reverse networks including asset tracking and demand and supply balancing tools, as well as broadening the capacity and reach of the reverse network to serve all major markets in Europe. This system extracts data remotely from all contracted machines (e.g. number of copies made) and is used to determine which route through the cascade a machine should take (i.e. the smaller the number of copies a machine has made the lower the cost of remanufacture as parts replacement levels will be lower). Even with the decision-tree the company has found that no matter how much the process is automated, the prioritisation and routing of assets through the cascade requires continual iterations of manual intervention and management decisions. The strategic challenge for the company is what balance of actions is required to maintain its remanufacturing business and the inherent risks in design for remanufacture in the event of future technological leap via reliance on traditional fossil fuel material choices. The value asset tree highlights that a CBM set-up is a dynamic system that is needed to respond to commercial pressures, regulatory change and innovation cycles. The ability to sustain this value capture relies on a wide range of capabilities, investments and enabling conditions.

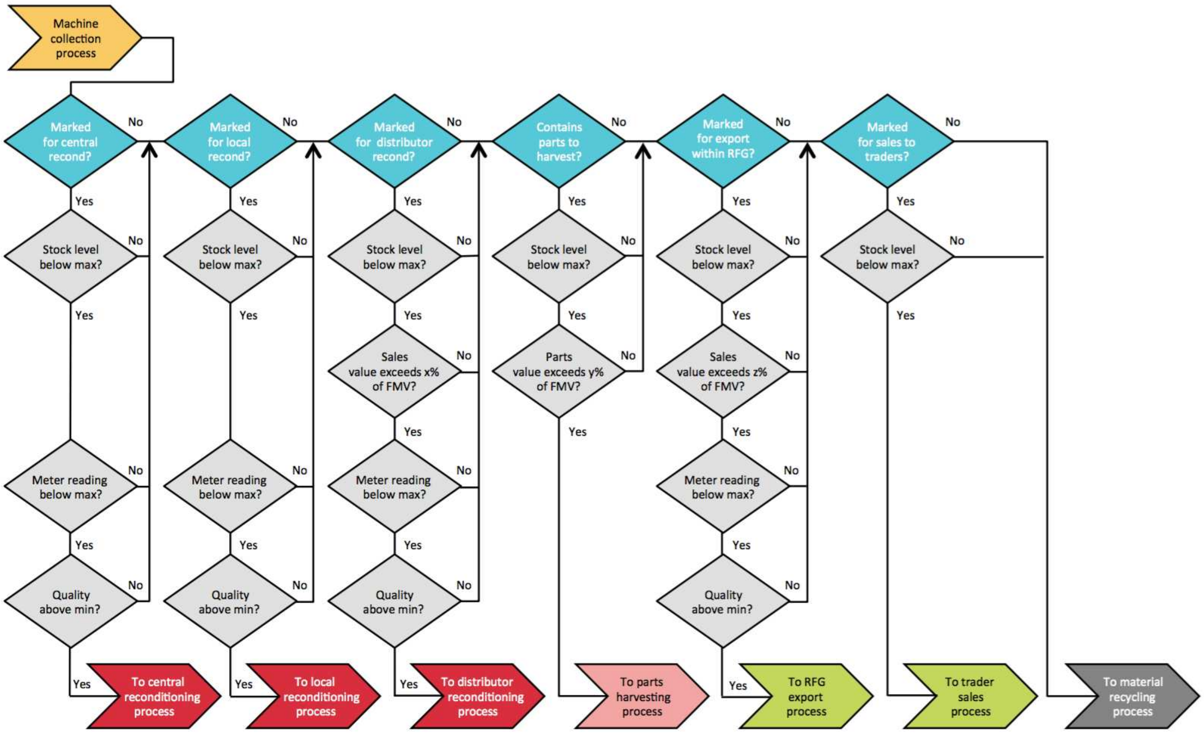


Figure 2: Company C Asset Value Capture Cascade

4. Discussion and Conclusion

The case examples presented in this paper were selected to review and illustrate the role of four building blocks, originally developed as heuristics in the practitioner's literature, as potentially useful for conceptualising how different firms realise value creation and capture that follow the idea of a circular economy. These examples and the inferences are drawn from materials and discussion of case materials within a Circular Economy Masterclass, where professionals and practitioners from the host companies and numerous other leading CE companies explore the challenges and opportunities to close the CE implementation gap. The three cases share some elements and similarities to the classes and categories of BMs and CBMs reviewed in the paper e.g., leasing, remanufacture, product extension etc. In this paper, we discuss the dynamic nature of these BMs and, within the limits of commercial confidentiality, how they are configured in different ways in each real world case example to deliver measurable value creation and capture. Moreover, we differ from other studies in defining and delineating the term BM as focal point for how a business makes money from CE – suggesting three common means: internalisation, resale and performance. There are other ways to generate revenues and these three mechanisms can be configured in different ways as we have seen in the cases of Company A, B and C. These mechanisms, however, are themselves critically dependent on product and service design, the management and co-ordination of reverse networks and the ability to shape strategy and operation to adapt to regulatory, legal, financial and customer enablers and constraints that help form the wider system. In each of the three cases, the realisation of value from CE principles is iterative, emergent and one that becomes increasingly complex and boundary spanning, requiring new forms of collaboration, internal capabilities and strategic elements.

In the case of Company A its strategy is underpinned by a combination of dedicated exclusive long term relationships and ability to control value chain activities. They are now at a point where new value chain partnerships and opportunities are emerging, driven by digital technology, increasing the product-service value creation, capture and distribution and building relationship into new areas.

Company B has grown from a successful refurbishing business to high value remanufacturing to a vision as a future company driven by CE sales and revenues. To achieve this it is configuring multiple BMs, design processes and extended reverse network activity system and competitive business environment generate a positive shift to circular value capture. Internal transformations are underway to build skills, knowledge and capabilities, to enable the company to scan and rapidly assess new circular solutions and propositions with increasing agility and assurance.

Company C highlights how a tight coupling of product design, BM, reverse network and specific system enablers formed the essential platform for a global circular activity system extending beyond the firm. The lesson from this form is that the ability to scale up practices takes time and requires an ability to manage and negotiate a complex and nuanced interplay between different building blocks. Even as a series of practices becomes established, this is not the end of the story as successful initiatives – such as the company C, shows that these may come under threat from technical innovations or changing customer preferences. Figure 3 below compares and summarises the role of each building block in the three cases examined.

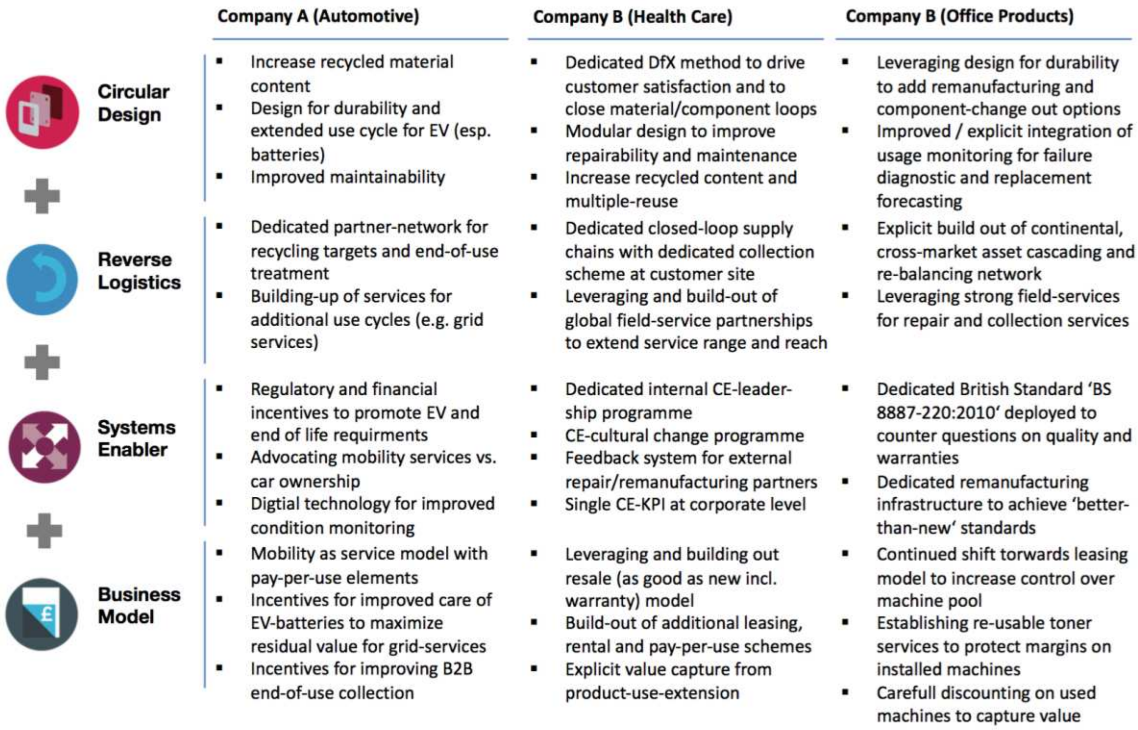


Figure 3: Building blocks in the three cases examined

The paper provides practical real world examples of CE implementation at scale and extend the contribution to the CE 'closed-loop' research model proposed by Babbit et al. (2018). In doing so, the case examples revisit a practitioner's heuristic to explore how circular value is created and captured in a real world context and by inference, from discussions with practitioners, the role of four systemic factors influencing the effective and successful implementation of circular strategies, contributing to the much needed more systemic focus in CBMs studies to advance understanding of the factors influencing the adoption of circular strategies emphasised in recent literature (Lüdeke-Freund et al., 2019; Zucchella and Previtali, 2019).

To be fully in accord with the call for consolidation of the CE literature expressed by Babbit et al. (2018), we identify some future research questions deriving also from the findings and challenges resulting from our cases. Firstly, the research into CBMs classification needs to engage more fully with the longer tradition of BM research to identify points of alignment and enrichment. CBMs research has been helpful in classifying and defining different types of BMs and their potential ways of circulating products, components and materials. There now needs to be a move from description to explanation of the value realisation process. Hence, secondly, further research is needed to engage with a deeper understanding of the four circular buildings blocks as an activity system and to test and explain their relationship to actual rather than theoretical value creation and capture. Consequently, more real world examples are needed to provide detailed quantification and evidence to illuminate the actual societal or business value created and captured from CE, and then evaluate the processes and the challenges involved in creating successful circular businesses at scale. Additionally, here we concentrated on large companies but SMEs should form the subject of future studies as they are relevant for the transition to a CE given that in Europe, where the transition towards the CE is high on the agenda for a more resource efficient economy, they account for 99% of businesses and for more than half of the EU's Gross Domestic Product (EC, 2013).

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